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SERVICE TRIALS UNIT

R.N. AIR STATION

FORD

SUSSEX

SECRET

Report Number 509/52 Preliminary Performance Assessment of

A.S.V. Mark 19B

Date: - 12th February 1952

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PRO file reference ADM 335/77

1. INTRODUCTION.

(a) Authorisation.

Trial number 533/Misc/182 was authorised by Flag Officer, Air (Home)'s form 101 number 1545/579F/460 dated 24th May 1951, which was accompanied by a questionnaire and by Admiralty letter A/AWD/401/50 of 7th May 1951.

(b) Officers concerned.

Lieutenant Commander G.T. Turner R.N.	Observer.
Mr G.L. Holmes – Commissioned Observer R.N.	
Lieutenant G. Dunworth R.N.	Pilot.
Lieutenant (L) K. Lobb R.N.	Electrical Officer.

(c) Sorties and Flying Times.

Lieut. Cdr. Turner	6 sorties	11 hrs. 50 mins.
Mr G.L. Holmes	26 sorties	44 hrs. 40 mins.
Total	32 sorties	56 hrs. 30 mins.

(d) Previous reports.

An interim report, number 507/51, was issued on this equipment on the 31st December 1951.

A previous report, number 511/50, on the commercial predecessor of this equipment, was issued on the 31st July 1950.

2. OBJECT OF THE TRIAL

The object of the trials is the preliminary performance assessment of the equipment before the full Service trials, with particular reference to the suitability of the scanner, indicators and the control unit.

3. DESCRIPTION OF THE EQUIPMENT

A.S.V. 19B radar equipment has been adapted from the cloud and collision warning equipment manufactured by E.K.Cole Ltd. preliminary service trials of which were carried out by an observer from this unit between 17th and 25th July 1950.

The major differences between the original and this equipment are the provision of one larger indicator using a six- inch cathode ray tube and the use of scanner X 432. The set now provides: -

i. P.P.I. on 10 and on 40-mile ranges.

ii. An open centre control on the 10-mile range to give more accurate bearing indication at short ranges.

iii. Range markers, which appear as concentric circles every 2 miles on the 10-mile range and every 5 miles on the 40-mile range. A marker on/off switch and brilliance control has been provided for these trials but it is understood that the on/off switch will be deleted from future equipments.

iv. Scanner stabilisation in roll and pitch, and tilt control of the 6-degree beam between 5 degrees up and 10 degrees down.

4. CONDUCT OF THE TRIAL

One flight with this equipment was carried out on 5th. September 1951, after which the equipment required servicing,

Five sorties were carried cut in the Portland area between 2nd. and 5th. October, with very promising results, after which the equipment again became unserviceable and the aircraft returned to Defford,

The aircraft returned to R.N. Air Station, Ford, on 23rd. October, and one sortie was carried out. Ranges obtained were low compared with those obtained in similar conditions between 2nd. and 5th. October, and the presentation was generally jittery end unstable. The aircraft therefore returned to Defford for further servicing of the equipment by the Telecommunications Research Establishment Malvern.

An observer from this Unit was detached to the Telecommunications Flying Unit, Defford, on the 20th November in an effort to speed up the trial. The excessive jitter had been cleared in the main by this date by T.R.E. but several other faults were still apparent, and much work: and many test flights were carried out before the equipment was judged to be fully serviceable on 29th, November.

The -aircraft was detached to R.A.F. Station, St Mawgan, on the 28th November to progress comparative trials with A.S.V. 13 installed in Shackleton aircraft (A.S.W.D.U. TRIAL 311 - 'Caster and Pollux'). The target used during this trial period was the trellis-topped international marker buoy off Godrevy Island. and ranges obtained compared favourably with ranges obtained by ASV-13 on the same target at the same time, but it was subsequently shown that all these ranges were below average. The Anson therefore returned to Defford and the trial was stopped until units that had been overhauled by the contractors became available. These units (the transmitter receiver, synchroniser and control unit) were installed and the aircraft returned to St. Mawgan by 6th December 1951. The general performance of the equipment, particularly the A.F.C. and the Tilt systems, was below the required standard and results, although much the same as those of the previous week, were disappointing compared to those obtained by ASV-13 in Shackleton's.

The aircraft returned to T.F.U. Defford on the 14th December and the radar equipment, together with the non-airworthy set used for bench testing by T.F.U. Defford was returned to T.R.E. The transmitter-receiver from the aircraft was returned to the contractors on 31st December for further investigation.

R.N. Air Station Ford was closed for the Christmas leave period from 18th December until 3rd January 1952.

An observer from the Service Trials Unit was lent to T.F.U. Defford on the 7th January to progress the trial and at the request of T.R.E. Malvern, an officer from the equipment and Trials section H.M.S. Ariel. Further very willing co-operation was forthcoming from Messer's. Gard and Oxborough from E.K. Cole Limited and a considerable amount of work was completed by this team during the period 7th to 14th January.

As no Shackletons were available from A.S.W.D.U. for the comparative trial between ASV 19B and 13, it was decided to continue operating from Defford to facilitate servicing of both the equipment and of the aircraft, and a total of 10

hours 40 minutes flying was completed against various targets in the Bristol Channel.

During this period the weather was consistently bad, and on the 9th January the radome was damaged when the aircraft flew through a violent hailstorm for about 30 seconds. Photographs of the damage and a technical appreciation are included under the maintenance section of this report (Missing). The equipment itself continued to give complete satisfaction.

It was expected that further progress could be made on the comparative trial with ASV 13 at St. Mawgan, so the Anson left Defford for St. Mawgan on the 21st January 1952. Unfortunately unserviceability prevented Shackleton co-operation throughout the week; one combined operation was attempted but the Shackleton was forced to return to base by engine failure after two runs on the target. Anson VM 306 continued to operate in the area, and during the period 21st to 25th January the equipment operated satisfactorily against a wide variety of targets, including the marker buoy off Godrevy Island.

Results were good and compared favourably with the majority of those obtained by ASV 13 on previous occasions, but due to the unserviceability of the Shackletons the S.T.U. observer had no opportunity to operate ASV 13 and so give a more realistic comparison.

A second transmitter-receiver unit, brought as a spare was tried during the week to check that the modifications carried out by the contractor had cured the previous A.F.C. faults. This was proved, and the results obtained were comparable with the other, but it could not be used due to the recurrence of range marker jitter. This is an old fault known by the contractors, and subsequent T.R. Boxes have been suitably modified to prevent its recurrence.

5. OPERATIONAL PERFORMANCE

(a) Maximum Range

Detailed figures of the detection ranges against various types of targets are given in the appendices.

Since the scanner was positioned in the nose of Anson VM 306, only forward looking was possible; the fuselage effectively blanked all echo’s from approximately 10 degrees aft each way.

Two ranges are quoted in the appendices and are classified as: -

I. Detection range

The range at which a target could be detected if its approximate relative position were known. At such a range, painting occurs once every three or four scans, and would possibly be missed by an operator doing an all round scan

II. Tracking range

The range at which a reasonably consistent painting occurs, and at which there is little possibility of an operator missing the ‘blip’

(b) Target discrimination

Target discrimination is considered to be adequate for all normal A.S.V. search requirements. Two examples are given: -

I. The Scilly Islands, which first appeared as a single echo at 35 to 37 miles, split into five clearly recognisable groups at 25 miles – approach course 260 degrees true.

II. A large tanker steaming a half to one mile offshore on a course parallel to the coast was clearly identified as a single echo when stern on at a range of 25 miles.

(c) Accuracy of ranges and bearings.

The cursors supplied for this trial were marked with 30 degree/bearing lines only, and were made adjustable vertically and horizontally, so that a reasonable compromise in centring the trace could be made between the two indictors, which have common X and Y plate shift controls.

No inspection of the scanner was possible without removing the radome, so the cursor had to be lined up to the ahead position by inspection of the trace itself, which is not an accurate method. In addition, the bolts securing the cursor served also as securing studs for the visor, and it was possible to involuntarily alter the position of the cursor each time the visor was shipped or unshipped. The cursors when mounted were too far from the face of the tube, which gave rise to considerable parallax errors.

5 (c) continued

It was found that it was impossible to estimate correctly the bearing of any target on the 40-mile range due to the above inaccuracies, but on the 10-mile range these faults were not so apparent. It was found that all targets could be tracked very accurately down the ‘on top’ position.

Accuracy of range estimation depends almost entirely on the accuracy with which the range marker circuit is set up. No errors were found at any time when comparing radar ranges with those from maps and charts, and the changeover of ranges from the 40-mile to the 10-mile range produced no inaccuracies.

(d) The effect of sea clutter

If the target can be picked up outside the range of sea returns, it can be tracked to the zero range for that height. An experienced operator can also do this if the target is detected up to two miles inside the extent of sea returns. It must be emphasised, however that in both cases considerable experience is required to achieve this on a small target since it requires critical manipulation of ‘tilt’, ‘gain’ and ‘brilliance’ controls, and possibly the use of the sea clutter filter.

The sea clutter filter as originally fitted was found to be much too fierce and was virtually useless when it was most required, homing on small targets in conditions of heavy sea returns. A service modification was carried out on the filter fitted to the rear indicator with a fair degree of success, but due to the high sensitivity of the receiver and the consequent rise in amplitude and extent of sea returns, investigation into the provision of an efficient sea clutter filter is still outstanding.

(e) Minimum range

Minimum range due to height, which were reasonably consistent in sea states of up to 4 were found to be as follows: -

2,000 feet	1 ¾ miles
1,000 feet	1 mile
500 feet	¼ mile
200 feet	zero

In sea states of 5 to 6 these minimum ranges were increased by approximately ¼ mile, but in these conditions zero range could always be reached if the height was reduced to 200 feet. No sea states greater than 6 were experienced throughout the trial.

6. MAINTENANCE

(a) General

At the start of the trial it was not expected that much new or conclusive information bearing on service maintenance would be obtained, for the following reasons: -

i. The transmitter-receiver, synchroniser (with its front panel serving as a junction box), servo-amplifier and controller were of the early cloud and collision warning radar series, of which fair experience had already been gained in previous Anson and Firefly installations and on the bench. Previous comments on these units are well known, and are catered for in the production ASV 19B series.

ii. The indicators fitted were also of the original type, one fitted with a CV 1530 cathode ray tube (a six inch tube using the same electrical circuits) and the other with a lens to give a magnified presentation, both indicators being modified to include individual control of range marker intensity and a sea clutter filter as used in ASV 15. The larger tube has been adopted for ASV 19B, but no fully engineered model was available for the trial.

iii. The scanner X 432 was the first experimental model with many known defects, which will not be present in subsequent models.

iv. The aircraft was to be based at Defford, where any aircraft maintenance required would be carried out, while the responsibility for radar maintenance was to be that of T.R.E.

v. No airworthy replacement units were available in case of failure, and test equipment for the first line use was limited to a Monitor X 469, an echo box TS 62 and a Monitor 52, which was permanently installed in the aircraft.

It was accordingly decided to allocate one Radio Electrician (Air) to this project, liaison at office level being carried out at Defford and T.R.E. during any necessary maintenance or modification work.

(b) Narrative

First Phase – 1st October to 30th November 1951

1st Oct. The equipment was satisfactorily flight tested and flown to R.N.A.S. Ford.

2nd-4th Oct. Equipment operated satisfactorily.

5th Oct. The aircraft was returned to Defford as the gyro unit failed to erect. This was removed and subsequently returned to R.A.E. for investigation, a Control Unit type 512 being fitted for the remainder of the trial.

9th Oct. The aircraft returned to Ford.

10-16th Oct. The aircraft was unserviceable due to airframe damage. The following faults developed on the ASV installation.

i. Open circuit video lead to the second indicator

ii. Faulty time base valve (CV 138) in the synchroniser

iii. A slight time base jitter developed, but was not traced.

Note: During this time servicing was attempted by two Radio Electricians (Air) and by an Experimental Officer from T.R.E., but conditions were very unsuitable as there were no spare parts, no bench facilities and the units in the aircraft were not easily accessible.

17-18th Oct. The slight jitter was accepted, the equipment otherwise serviceable.

19-20th Oct. The aircraft was returned to Defford for engine maintenance

23rd Oct. The aircraft and radar were serviceable and were flown to ford, where ranges obtained were poor

24-26th Oct. The aircraft returned to Defford where a performance check was carried out, the Transmitter-receiver re-aligned, a new crystal (CV 253) fitted, and the I.F. Strip checked at T.R.E. An improvement in performance resulted, and a tendency to overload tripping was traced to too high an output voltage from the motor generator type 4B. This was rectified.

29th Oct. 7th Nov A serious attempt was made to locate the origin of the time base jitter, the following contributory causes being found: -

i. Poorly fitting valve holders in the synchroniser giving intermittent contact with vibration.
ii. Vibration arising from an unbalanced blower motor fan in the synchroniser.
iii. Microphonic valve, paraphrase amplifier (VC 138) in the synchroniser.

During this period connector faults developed giving loss of signal crystal current and three phase voltages. These faults were rectified.

<u>Maintenance Cont</u>.

8-23rd Nov. During this period it was confirmed that the R.F. performance was satisfactory, but the loss in overall performance was due to poor operation of the A.F.C. circuit, which was subject to intermittent fast fluctuation, the cause of which could not be traced. During this period and later, less T.R.E. effort could be made available as the trial and its attendant investigations were lasting longer than had been anticipated. A service modification, increasing a condensor value, was made to the second indicator to make the sea clutter filter less fierce in operation. A limiting crystal diode (CV 448) failed in the first indicator, but this circuit will not be included in the final version of the indicator.

27-29th Nov. The aircraft operated from St. Mawgan, but the level of performance reached in early October was not attained.

<u>Second phase – 30th November to 31st. December 1951</u>

30th Nov. At a progress meeting at the contractors, E.K. Cole Ltd., it was decided to suspend the trial until and overhauled system, less the scanner, could be provided by the contractor, to be on loan for the remainder of the trial.

4-5th Dec. The replacement transmitter-receiver, synchroniser and controller were installed and accepted by T.R.E.

6-7th Dec. The aircraft operated from St. Mawgan, but the general performance and the A.F.C. circuit were still not up to the required standard.

10-17th Dec. Ditto

31st Dec. The Transmitter-receiver was returned to the contractor for investigation.

Third phase – 3rd January to 28th January 1952

3rd Jan. At the ASV 19 progress meeting it was agreed that the trial should be brought to a conclusion as soon as possible and that the contractor should be invited to fly with the system to assess its performance, in an endeavour to clear up the A.F.C. troubles. At T.R.E. request the technical co-ordination for the remainder of the trial was undertaken by the Air Officer of the Equipment and Trials Section, H.M.S. 'Ariel' working direct with the contractor as necessary.

7-8th Jan. Measurements of S.W.R. and frequency pulling were made on the installation to prove that the A.F.C. variations were not due to imperfections in the Waveguide run or scanner. The results were uniform and of a high order.

9-11th Jan. The following modifications were carried out by the contractor: -

i. The A.F.C. circuit in the transmitter-receiver was modified to include damping resisters of 1K across L201 and L202, reducing the gain and giving better lock-on discrimination between the I.F. and the second harmonic of half the I.F.

ii. The synchroniser was modified to improve range marker intensity by increasing C26 to 68pf and to reshape the bright-up reducing intense brilliance at the centre of the indicator, by increasing R61 to 100K.

Subsequent ground and air testing disclosed the following: -

i. Connector faults had developed leading to the loss of three phase supplies and the loss of the horizontal deflections to the second indicator.

ii. Stabilisation was inoperative, and the control unit type 512, which had become very stiff to cage and un-cage was replaced. The faulty unit was later lubricated and worked satisfactorily. Tests were carried out on the servo system using dummy gyros, and its operation adjusted to give oversawing for 5 degrees displacement, instead of 10 degrees as previously aligned. This was done to improve stabilisation, which was sluggish in rough air.

9-11th Jan.Cont.

iii. The A.F.C. was intermittent in operation and Klystron voltages were abnormal, a subsequent investigation by the contractors disclosing an intermittent heater-cathode short circuit in the discriminator, CV 140.

iv. The R.F. performance was poor, and was found to be due to a low power magnetron, CV 370.

14-15th Jan. The installation functioned well, the performance being as good as that experienced at the beginning of the trials.

16th Jan. Repairs were carried out on the radome, which had been damaged by hail on the 9th January. Small patches of neoprene had flaked off, and the exposed laminate there-upon 'blistered'.

17-18th Jan Radar performance was good.

21-25th Jan The aircraft operated from St. Mawgan, the general performance being good, although at the end of this period there were equipment warning peculiarities (the absence of open centre, a short double-sided trace on the 40 mile range and an intermittent firing of the transmitter). These faults were repeated at the contractors on the 28th January, and were found to be due to low input voltages. The power supplies to be used for Gannet AS Mk1 will include an inverter type 202 with a thyraton control unit, giving 115v single phase supply controlled in voltage and frequency to close tolerances. A spare transmitter-receiver and synchroniser were borrowed from T.R.E. for this period and modified to the same standard as the aircraft system. The transmitter-receiver was tried in the aircraft in order to obtain a comparison but it produced woolly marker rings on the 10-mile range and was not flown. This fault was referred to the contractors, who had experienced it before in certain units. It is due to prepulse generator instability, and will not occur in production units.

(c) Remarks on individual Units

As has already been indicated, the experimental nature of the installation and the fact that it was not until the final phase of the trail that maintenance was under the direct control of the services do not allow fair answers to be made to the questionnaire, nor conclusions to be drawn from them. The following points did, however arise.

i. Stabilisation System.

(a) A marked improvement resulted after increasing the signal Vs feedback ratio in the servo-amplifier to give one overswing for 5 degrees displacement. However the scanner did not appear to move smoothly, but in a series of steps. The system is not difficult to set up in the aircraft.

(b) Insufficient experience was gained of the gyro unit type 5, as a control unit type 512 was in use for most of the trial.

ii. Tilt System.

A makeshift tilt system was in use, which was unstable and its relays gave 'splash' on the display.

iii. Scanner.

Full comment cannot be made on this early model, but sub-units are incorporated for ease of servicing. A directive feed was incorporated in the Waveguide run.

Maintenance Cont.

iv. Indicators.

No comment can be made on the layout or accessibility. The tube in use CV 1530D, although an improved version of the early CV 1530, is still subject to

electrostatic defects such as accelerator shadow, which if not appreciated lead to a distorted display. It is desirable to set brilliance to maximum during the warm up time to overcome this.

(d) Test Equipment.

In general the test equipment should be similar to that of ASV 19A with the addition of a small number of items peculiar to the scanner and stabilisation system.

7. CONCLUSIONS AND RECOMMENDATIONS.

(a) General

After a promising start to the trial in October 1951, considerable delay was experienced due to unserviceability. It is felt that this delay could have been greatly reduced if more continuity had been available in the day to day servicing of the equipment, and if the contractors had been approached earlier. Such action was pressed by the service representatives at T.R.E.. Continuity was only achieved when an officer from the equipment and trials section, H.M.S. 'Ariel' assumed responsibility for the technical co-ordination of the trial. When the contractors were invited to fly with the equipment the two major faults were investigated and rectification action taken within a week. The equipment subsequently flew for approximately 20 hours in 14 days without further adjustment.

From an equipment point of view the main advantage obtained from this trial was the investigation into the A.F.C. unit and its subsequent modification to give a more reliable performance facilitating alignment.

(b) The stabilisation System.

This has been improved by the adjustments detailed in the maintenance section of this report, but movement in both pitch and roll is still jerky. The effect of this operation operationally is that in turbulent flying conditions large sectors of the scan are missed as the aircraft rolls and pitches. It is realised that the type of aircraft to be fitted with ASV 19B will not be affected so violently by such conditions as an Anson, and for this reason this system is considered to be adequate if the fault cannot be cured without delay.

(c) The Tilt System.

The tilt system has given considerable trouble, but critismns of it are well know by T.R.E., who gave assurances that the faults experienced during this trial will not be repeated in later models of the scanner. These faults have been: -

(a) If the tilt was set at 5 degrees or above, the scanner could not be returned to horizontal except by breaking the scanner On/Off switch and inching the scanner while slowly moving the control towards zero. The higher positive tilt settings were therefore blanked off and will be deleted from future models.

(b) Excessive jitter occurred when the control was moved in a negative direction. This jitter, sometimes accompanied by time-base splash, steadily worsened as the trial progressed. To reach a given tilt setting of , say minus 4 degrees, it was necessary to move the tilt control to minus 7 degrees and then return to the required setting in a positive direction.

(c) Control of tilt is sluggish, and it is felt that the general operational usefulness of the equipment would be enhanced if the tilt follow-up

could be speeded up. It is, however, acceptable if this is likely to involve major modification action and the consequent delay in production.

(d) The Indicator Units.

Two indicators were fitted in this installation, a six-inch high intensity low persistence green tube, and a smaller medium intensity medium persistence orange tube fitted with a magnifier. Both tubes used the same electrical circuits, and had only one minor fault throughout the trial. The large tube has been adopted for ASV 19B but no fully engineered model was available for the trial. The following remarks are therefore made for completeness only.

i. The magnifier on the small tube was most effective, and in fact one of the two operators preferred the medium persistence amber colour as being more restful, while giving detection ranges comparable with the high intensity green tube. It is therefore recommended that both types of tube be used for the full service trials of the equipment.

ii. During the latter stages of the trial an amber filter was made locally and fitted to the main green, indicator. It proved most effective in reducing glare. It is felt by the operator concerned that the cursor itself could well be made of this colour, but as experience was limited to one operator it is recommended that both clear and amber cursors be supplied as alternative fittings for the full service trial.

iii. It is considered that the cursors supplied for this trial were positioned too far from the tube, which gave rise to excessive parallax error.

iv. It is recommended that the method of securing the cursors and visors be improved, since the act of fixing the visor to the indicator in the present method tends to move the cursor off alignment. The problem might be solved by locating the visor with securing studs athwartships. As present these studs secure both cursor and visor.

v. It has been recommended to T.R.E. that additional half inch lines be engraved around the circumference of the cursor to aid bearing estimation of distant targets for plotting purposes, and the cursors supplied for the full service trials will be so engraved.

(e) Visors.

The visors supplied for this trial are considered to be adequate, with the following provisions:-

i. The inside of the visor should be finished in dull black. The operators have been seriously affected by the extreme glare reflected from the inner walls of the indicator. This reflection was partly reduced when the amber filter, mentioned in Para. (d) (ii) above, was used, but was still in existence.

ii. Every effort should be made to achieve as close a fit as possible between and the visor and the front face of the indicator. This fault is not readily apparent in the Anson aircraft, which is conveniently fitted with sunblinds, but can be very troublesome in an aircraft not so fitted.

(f) The Control Unit.

This differs considerably in layout from the production version, and therefore only general recommendations can be made.

i. The scanner On/Off switch should be retained in the production version to enable the scanner to be stopped in order to facilitate tuning and

comparison of video strengths when estimating optimum tilt settings for various heights.

ii. The size and shape of the controls most often used is considered to be of equal importance to their relative position on the Control Unit. It is therefore recommended that the operational controls, which are the gain, brilliance, tilt and sea clutter filter controls, should be of such shape and size and be so positioned that they can be readily identified by touch. This is an essential requirement.

iii. It is further recommended that the focus control be placed away from those mentioned above. Time is sometimes lost at a critical stage of a homing if this control is moved inadvertently.

(g) Installation.

The following recommendations are made with particular application to the installation of ASV 19B in an Anson aircraft for full service trials, but recommendation (i) applies generally.

i. The installation should be laid out in accordance with service representatives, to make easy access to the following components: -

(a) The Gyro Unit, in case a control unit type 512 has to be used, which requires caging and un-caging in flight.

(b) The front of the transmitter-receiver and the directive feed.

(c) The junction box, the front of the servo-amplifier, and the synchroniser.

Generally speaking it is desirable to have to remove one or more units in order to reach another.

ii. Two complete sets of units produced to ASV 19B standards should be used, with a fully engineered scanner.

iii. A new radome will be required (after the damage to the original one) and an access panel to the scanner components should be incorporated inside the aircraft to facilitate alignment of the servo system and the indicators.

iv. The radar primary supplies should conform to those used in Navel aircraft.

v. The intercommunication system should be modified to the users requirements.

vi. Test equipment to enable a daily assessment of performance to be made should be provided.

Signed

Lieutenant Commander R.N.
A/Commanding Officer
Service Trials Unit.

(Secret de-classified 2002)

APPENDIX	I	Results on small targets
APPENDIX	II	Results on Ships
APPENDIX	III	Results on Miscellaneous Targets